In the Claims

The claims remain as follows:

1. (original) A method of measuring the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components, the method comprising determining the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

2. (previously presented) A method as claimed in Claim 1, wherein the analysis is performed in a high bit error ratio area of the function, away from a center of an eye, and in a low bit error ratio area closer to the centre of the eye.

3. (previously presented) A method as claimed in Claim 2 , wherein the analysis comprises the steps of:

determining BER values as a function of the position of said movable decision threshold in said high bit error ratio area and in said low bit error ratio area;

extrapolating the BER values in both the high bit error ratio area and the low bit error ratio area to obtain respective first and second decision threshold values corresponding to a predetermined value of BER in both the high bit error ratio area and the low bit error ratio area;

determining the difference V1 between said first and second decision threshold values in the low bit error ratio area;

determining the difference V2 between said first and second decision threshold values in the high bit error ratio area; and

determining the ratio V1/V2 as a measure of the amplitude distortion component of the signal.

4. (original) A method as claimed in Claim 3, wherein said predetermined value of BER is 0.25.

5. (original) A method as claimed in Claim 1, wherein said analysis is performed on values of BER after Q conversion in accordance with the function $Q = 2^{1/2}\mathrm{erfc}^{-1}(4\mathrm{xBER})$, in which *erfc* is the complementary error function.

6. (original) A method as claimed in Claim 1, further comprising the step of providing said BER values by comparing the said signal with a said variable decision threshold.

7. (previously presented) A method as claimed in Claim 2, further comprising the steps of:

estimating a second bit error ratio by projecting BER values from said first and second decision threshold values in the high bit error ratio area and at the same gradient as said extrapolations in the lower bit error ratio area; and

determining the intersection of said projected BER values to obtain an estimated BER value, indicative of an optical signal-to-noise ratio of said optical signal.

8. (original) A method as claimed in Claim 1, performed by a programmed computer.

9. (original) An optical transmission system comprising measuring means to measure the amplitude distortion component in an optical transmission signal subject to noise and amplitude distortion components, the measuring means adapted to measure the amplitude distortion component by analysing the bit error ratio (BER) of the signal as a function of a movable decision threshold.

10. (previously presented) An optical transmission system as claimed in Claim 9, wherein said measuring means is adapted to perform said analysis in a high bit error ratio area of the function, away from a center of an eye, and in a low bit error ratio area closer to the centre of the eye.

11. (original) An optical transmission system as claimed in Claim 10, wherein said measuring means comprises:

BER determining means to determine BER values as a function of the position of said movable decision threshold in said high bit error ratio area and in said low bit error ratio area;

BER extrapolating means to extrapolate the BER values in both the high bit error ratio area and the low bit error ratio area to obtain respective first and second decision threshold values corresponding to a predetermined value of BER in both the high bit error ratio area and the low bit error ratio area;

first difference determining means to determine the difference V1 between said first and second decision threshold values in the low bit error ratio area;

second difference determining means to determine the difference V2 between said first and second decision threshold values in the high bit error ratio area; and

dividing means to determine the ratio V1/V2 as a measure of the amplitude distortion component of the signal.

12. (original) An optical transmission system as claimed in Claim 11, wherein said predetermined value of BER is 0.25.

13. (original) An optical transmission system as claimed in Claim 9, wherein said analysis is performed on values of BER after Q conversion in accordance with the function $Q = 2^{1/2}\mathrm{erfc}^{-1}(4\mathrm{xBER})$, in which *erfc* is the complementary error function.

14. (original) An optical transmission system as claimed in Claim 9, further comprising comparing means to provide said BER values by comparing the said signal with a said variable decision threshold.

15. (original) An optical transmission system, comprising optical receiver means to detect optical transmission signals and convert them into their electrical equivalent, clock extraction means to extract clock timing signals from the received optical signals, first and second digital-to-analogue converters providing first inputs to first and second analogue amplifiers, said optical receiver means providing second inputs to said first and second analogue amplifiers, first and second bi-stable circuit means connected respectively to outputs of said first and second analogue amplifiers and synchronised by said extracted clock signals, outputs of said bi-stable circuit means connected to inputs of an exclusive-OR gate, an output of said exclusive-OR gate providing error signals input to a counter, whereby said counter accumulates a count representing the bit error ratio in said received optical signals, and said digital-to-analogue converters being controlled by processor means to determine decision threshold separations V1 and V2 in the eye that represent amplitude distortion components in said received optical signals.

16. (original) A computer program adapted to perform the method steps of Claim 1.

17. (original) A carrier on which is stored a program adapted to perform the method steps of Claim 1.

18. (original) An optical transmission system incorporating a processor programmed to perform the method claimed in Claim 1.

19. (original) An optical transmission system incorporating a processor adapted to operate in response to a carrier as claimed in Claim 17.

20. (original) An optical receiver comprising detector means to detect optical signals from an optical transmission system and convert them into their electrical equivalent, the receiver comprising measuring means to measure the amplitude distortion component in a said optical signal subject to noise and amplitude distortion components, the measuring means adapted to measure the amplitude distortion component by analysis of the bit error ratio (BER) of the signal as a function of a movable decision threshold.

21. (previously presented) An optical receiver as claimed in Claim 20, wherein said measuring means is adapted to perform said analysis in a high bit error ratio area of the function, away from a center of an eye, and in a low bit error ratio area closer to the centre of the eye.

22. (previously presented) An optical receiver as claimed in Claim 21, wherein said measuring means comprises:

BER determining means to determine BER values as a function of the position of said movable decision threshold in said high bit error ratio area and in said low bit error ratio area;

BER extrapolating means to extrapolate the BER values in both the high bit error ratio area and the low bit error ratio area to obtain respective first and second decision threshold values corresponding to a predetermined value of BER in both the high bit error ratio area and the low bit error ratio area;

first difference determining means to determine the difference V1 between said first and second decision threshold values in the low bit error ratio area;

second difference determining means to determine the difference V2 between said first and second decision threshold values in the high bit error ratio area; and

dividing means to determine the ratio V1/V2 as a measure of the amplitude distortion component of the signal.

23. (original) An optical receiver as claimed in Claim 22, wherein said predetermined value of BER is 0.25.

24. (original) An optical receiver as claimed in Claim 20, wherein said analysis is performed on values of BER after Q conversion in accordance with the function:

$Q = 2^{1/2}erfc^{-1}$ (4xBER), in which *erfc* is the complementary error function.

25. (original) An optical receiver as claimed in Claim 20, further comprising comparing means to provide said BER values by comparing the said signal with a said variable decision threshold.

26. (original) An optical receiver comprising detector means to detect optical signals from an optical transmission system and convert them into their electrical equivalent, clock extraction means to extract clock timing signals from the received optical signals, first and second digital-to-analogue converters providing first inputs to first and second analogue amplifiers, said optical receiver means providing second inputs to said first and second analogue amplifiers, first and second bi-stable circuit means connected respectively to outputs of said first and second analogue amplifiers and synchronised by said extracted clock signals, outputs of said bi-stable circuit means connected to inputs of an exclusive-OR gate, an output of said exclusive-OR gate providing error signals input to a counter, whereby said counter accumulates a count representing the bit error ratio in said received optical signals, and said digital-to-analogue converters being controlled by processor means to determine decision threshold separations V1 and V2 in the eye that represent amplitude distortion components in said received optical signals.

27. (original) An optical signal received by an optical receiver as claimed in Claim 20.

28. (original) A computer programmed to perform the method of Claim 1.

Remarks

No amendments are made to the claims since Applicants firmly believe that the invention as presently claimed is patentable over the prior art references raised by the Examiner.

The Examiner has maintained his rejection of claims 1, 6 and 27 under 35 USC 102(b) as being anticipated by Taga et al (US 5,585,954) and his rejection of claims 8, 16-19 and 28 under 35 USC 103(a) as being unpatentable over Taga in view of Scholz et al (US 5,325,397).

Applicants have explained in their previous response of March 17, 2006 why Taga does not teach measuring noise or amplitude distortion. Applicants maintain their previous response as entirely pertinent.

The Examiner has continued to disallow the application in the April 13, 2006 Advisory Action, arguing that: "Taga disclosed that signal detector output is composed to the pseudo-random generator the [sic] check for differences. This provides the data that can be used for determining noise regardless if the term is used or not."

The cited passage merely teaches how signal decision circuit 5 determines whether or not a bit error has occurred. Bit error rate (BER) is used directly to calculate a Q value. There is simply no teaching in Taga of determining an amplitude distortion component of an optical transmission signal as required by the claims.

The Examiner states that certain data can be used for determining noise. This is not sufficient to substantiate a claim rejection under 35 USC 102. The Examiner, as a matter of law, is required to show how each and every element of the claim is taught by the prior art reference (MPEP 2131). Applicants deny that one skilled in the art

would find any teaching in the passage cited by the Examiner that would enable him to measure noise or amplitude distortion. The Examiner's assertion is simply unsubstantiated.

Perhaps the following explanation of the present invention will assist the Examiner in understanding the differences over conventional Q measurement approaches such as taught by Taga.

The operation of the invention may be best explained by way of an example. Figure 1 shows an optical transmission system consisting of an optical multiplexer, a booster amplifier, three spans of transmission fibre of length 80 km, three amplifiers which incorporate dispersion compensation and an optical de-multiplexer. When the system is operating normally the signal that emerges from the de-multiplexer at point X has a Q factor of about 14 which means that no errors are seen.

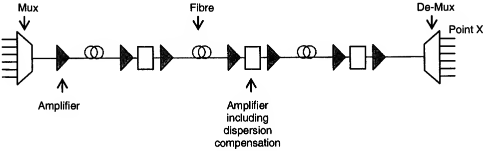

Figure 1 – Example transmission system

Figure 2 shows the signal that emerges from one of the ports of the de-multiplexer (point X) under these conditions. On the left is the "eye diagram" of the optical signal with no noise present (of course it would not be possible to see this in a real system) and on the right is the "eye diagram" that would be measured. This is the signal on the left together with the noise due to the optical amplifiers.

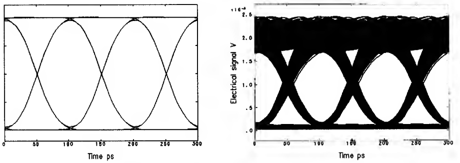

Figure 2 – Eye diagrams at point X

Now, consider two possible faults in this system. Fault A is the omission of the dispersion compensation module from the second line amplifier as shown in Figure 3.

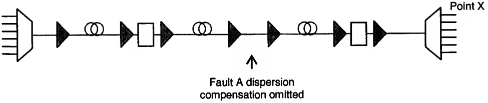

Figure 3 – Fault A

This fault causes considerable distortion of the signal seen at point X. This is illustrated in Figure 4. As before, on the left is the "eye diagram" of the optical signal with no noise present and on the right is the "eye diagram" of the distorted signal together with the noise due to the optical amplifiers. The noise level is substantially the same as it was without the fault, but because the "eye" is partially closed, the ratio of the eye opening to the noise is reduced and the Q factor has reduced to 6.6 which is equivalent to a Bit Error Ratio (BER) of about 2×10^{-11}

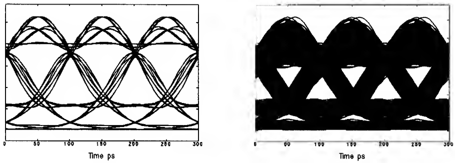

Figure 4 – Eye diagrams at point X due to fault A

Fault B is illustrated in Figure 5. Here, a splice within one of the optical amplifiers has a very high loss leading to much more noise than expected to be added to the optical signal.

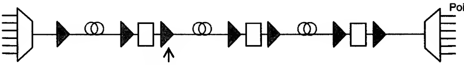

Figure 5 – Fault B

This fault does not distort the optical signal as can be seen on the left of Figure 6. The eye diagram on the right, however, is closed by increased noise causing the Q factor to be reduced to 6.6 which is equivalent to a Bit Error Ratio (BER) of about 2 x 10^{-11} which is the same as for fault A.

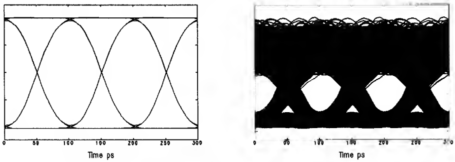

Figure 6 – Eye diagrams at point X due to fault B

Conventional Q measurement such as that disclosed by Taga simply sweeps the decision threshold of an error detector through the center portion of the eye and reports the Q factor. For both faults A and B this is 6.6. In other words the methods disclosed by Taga cannot tell the difference between the two faults.

In the present invention, in contrast to this, by determining at least the amplitude distortion component, an evaluation of the noise level that is not relative to the eye is possible. This is not taught or possible using the methods disclosed in Taga.

Since Taga fails to teach the feature of determining an amplitude distortion component of an optical transmission signal, Applicants firmly believe that claims 1, 6 and 27 are allowable.

Dependent claims 2 to 8 and 16 to 19 and 28 depend on claim 1 and so are allowable for the same reasons. Independent claim 9 has corresponding distinctive features to those of claim 1 and so is allowable for the same reasons. Dependent claims 10 to 14 depend on claim 9 and so are allowable for the same reasons. Claim 15 has already been allowed. Independent claim 20 has distinctive features corresponding to those of claim 1 and so is allowable for the same reasons. Dependent claims 21 to 25 and 27 depend on claim 20 and so are allowable for the same reasons. Independent claim 26 has been allowed.

All the points raised have been dealt with, all the claims are submitted to be allowable as cast, and reconsideration is requested.

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Respectfully submitted,

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